(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 October 2001 (04.10.2001)

PCT

(10) International Publication Number
WO 01/74079 A1

(51) International Patent Classification⁷: H04N 7/173

(21) International Application Number: PCT/US01/09739

(22) International Filing Date: 26 March 2001 (26.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/538,605 29 March 2000 (29.03.2000) US

(71) Applicant: SONY ELECTRONICS, INC. [US/US]; 1 Sony Drive, Park Ridge, NJ 07656 (US).

(72) Inventors: MARUO, Jun; Tomigaya, Shibuya-Ku, Tokyo 1-88-15-303 (JP). KAGAMI, Atsushi; Ru # 402, Komagome, Toshima-Ku, Tokyo 4-12-10 (JP).

(74) Agents: GALLENSON, Mavis et al.; Ladas & Parry, 5670 Wilshire Blvd., Suite 2100, Los Angeles, CA 90036 (US).

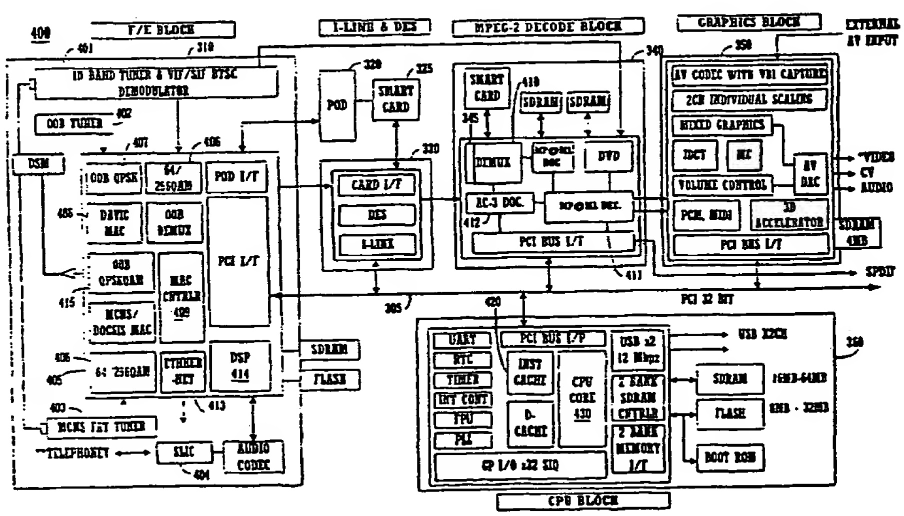
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SET TOP BOX COMPRISING MODULAR FUNCTIONAL BLOCKS



(57) Abstract: The architecture of an intelligent transceiver (e.g. set-top box) includes a plurality of modular functional blocks. One of the functional blocks is a front-end block (310) comprising an integrated circuit device (405) configured for bi-directional communication. In one embodiment, the front-end block also includes an in-band tuner (401) for receiving in-band digital signals from the digital broadcast system, an out-of-band tuner (402) for receiving out-of-band digital signals from the digital broadcast system, and a cable modem (403) for sending outgoing digital signals to and receiving incoming digital signals from the digital broadcast system. Thus, the devices necessary for bi-directional communication are located within a single block (e.g. the front-end block). Other functional blocks included in the intelligent transceiver are a conditional access block (330), an audio/video decoder (340), a graphics block (350) and a central processing unit (360).

WO 01/74079 A1

SET TOP BOX COMPRISING MODULAR FUNCTIONAL BLOCKS

BACKGROUND

FIELD

The present disclosure relates to the field of intelligent transceivers such as set-top boxes, in particular bi-directional set-top boxes. Specifically, the present disclosure relates to a method and apparatus for a modularized bi-directional tuning system. More specifically, the present invention pertains to a modular set-top box architecture in which the devices needed for bi-directional communication are substantially located in a single functional block.

BACKGROUND ART

Digital broadcast systems include direct broadcast digital satellite systems, interactive World Wide Web ("Web") access systems, and digital cable systems. Digital broadcasting provides a number of advantages to subscribers, such as variety and flexibility of programming, useful and comprehensive support services (such as detailed electronic programming guides), and superior audio and video quality. Subscribers receive broadcast digital signals via set-top boxes or other similar consumer electronic equipment located in the subscriber's home.

A set-top box performs a number of functions associated with processing a broadcast digital signal. In a typical prior art embodiment, the digital signal received by the set-top box is scrambled, and the signal is descrambled by the set-top box before further processing occurs. The descrambled signal is then encrypted within the set-top box in order to prevent unauthorized duplication and use ("pirating") of the descrambled signal. Once the encrypted signal is at

a more secure location within the set-top box, it is decrypted for further processing. The digital signal is typically in a compressed data format such as MPEG (Moving Picture Experts Group) for video signals and/or Dolby AC3 for audio signals, and so the decrypted signal is decoded (uncompressed) by the set-top box. After decoding, the audio content and video content contained in the digital signal are processed so that it can be viewed and/or listened to by the subscriber using, for example, a television set. In an intelligent set-top box, information and instructions associated with the above functions are stored in a memory unit and executed by a processor.

With a bi-directional set-top box (generally, a "transceiver" or "intelligent transceiver"), in addition to receiving and processing broadcast signals, a subscriber can transmit messages to the digital broadcast system operator (also referred to as a Multiple System Operator, MSO). Using a bi-directional set-top box, the subscriber selects a premium service offered by the MSO, such as a pay-per-view event or movie, and the subscriber's selection as well as information needed for billing purposes are transmitted to the MSO. In a common implementation, a "smart card" stores the information needed for billing, and on a periodic basis (perhaps once per month) an automatic connection is made between the transceiver and the MSO so that the billing information can be transmitted to the MSO.

A factor that should be considered when designing an intelligent, bi-directional set-top box is that different types of set-top boxes are needed depending on, for example, the market or the MSO. For example, a set-top box designed for use in Europe or Asia may be different than one designed for use in North America, although the primary functions of the set-top box (e.g.,

descrambling, encrypting, decoding, etc.) may be essentially the same for each market. Similarly, a set-top box designed for one MSO in North America may be different than one designed for another MSO in North America.

A problem in the prior art is that current intelligent, bi-directional set-top box designs offer little flexibility with regard to allowing a set-top box designed for one market or MSO to be readily adapted for use in another market or with another MSO. Thus, manufacturers of set-top boxes at great cost generally must design and manufacture several different types of customized set-top boxes. As a result, manufacturers of set-top boxes face increased development and fabrication costs. Clearly, for the benefit of the manufacturer as well as the consumer, it is desirable to minimize these costs.

Other factors that should be considered when designing an intelligent, bi-directional set-top box include the tremendous amount of data to be processed and the large number of operations that need to be performed on the data in order to perform the functions described above (e.g., descrambling, decoding, graphics processing, etc.). Consequently, the internal set-top box hardware may be somewhat complex and costly. In addition, the layout of the hardware within the set-top box may also be complex in order to accomplish the required interfaces and data exchanges between the various hardware components. These factors can also lead to increased costs for the manufacturer and ultimately for consumers. Accordingly, it is desirable to simplify the design of a set-top box without a decrease in, and preferably with an increase in, the overall processing and data handling performance of the set-top box.

SUMMARY

Accordingly, what is needed is an apparatus and/or method that can allow greater flexibility with regard to the design of intelligent, bi-directional set-top boxes for different markets and broadcast system operators, thereby reducing costs to manufacturers and consumers. What is also needed is an apparatus and/or method that can address the above need and that can simplify set-top box designs with an increase in the overall processing and data handling performance of set-top boxes.

The present invention includes an apparatus and method thereof that satisfy the above needs. These and other advantages of the present invention not specifically mentioned above will become clear within discussions of the present invention presented herein.

The present invention pertains to an apparatus and method thereof for enabling bi-directional communication between an intelligent transceiver (e.g., a set-top box) and a digital broadcast system (e.g., satellite systems, interactive World Wide Web access systems, and digital cable systems). In the present embodiment, the intelligent transceiver includes a plurality of functional blocks. The functional blocks are assembled in a modular architecture and coupled via a single bus. In the present embodiment, the functional blocks included in the intelligent transceiver are a front-end block for sending and receiving digital signals, a conditional access block for descrambling and encrypting a digital signal, an audio/video decode block for decoding the audio and the video

content of a digital signal, a graphics block for processing decoded audio and video content, and a central processing unit.

In the present embodiment, the front-end block of the intelligent transceiver is adapted to send a digital signal to and receive a digital signal from the digital broadcast system. The front-end block includes an integrated circuit device that is configured to provide all the capability for bi-directional communication required of the system. In one embodiment, the front-end block also includes an in-band tuner for receiving in-band digital signals from the digital broadcast system, an out-of-band tuner for receiving out-of-band signals from the digital broadcast system, and a tuner (e.g., a cable modem device) for sending digital signals to and receiving digital signals from the digital broadcast system. In another embodiment, the front-end block also includes a modem for making a telephone connection with, for example, the World Wide Web.

Thus, in accordance with the present invention, a modular architecture is used for an intelligent transceiver, and the devices needed for bi-directional communication are substantially located in a single functional block (e.g., a front-end block). Consequently, the manufacture of the intelligent transceiver is facilitated, and the design of the intelligent transceiver can be more readily adapted to the specific requirements of the market where it will be utilized, thereby reducing manufacturing costs.

In addition, communication between the devices used for bi-directional communication takes place in the front-end block. Accordingly, the amount of

communication required over the bus is reduced, thereby improving the overall processing and data handling performance of the transceiver. A high bandwidth bus is used to transfer audio/video data between the functional blocks (e.g., a Peripheral Component Interconnect [PCI] bus).

Advantageously, by placing all of the bi-directional communication functionality in one block (e.g., on one card), a specialized bus may be utilized in the front end block of the transceiver to maximize communication speed between devices on the front-end card, while simplifying the inter-module communication by requiring only a single, high-speed bus (e.g., a PCI bus). Since all of the modules, other than the front-end block, can be conventional in presently commercialized set-top boxes, product cost is minimized by adopting those other modules into the present system.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention:

FIGURE 1A is a block diagram of one embodiment of an intelligent transceiver upon which embodiments of the present invention may be practiced.

FIGURE 1B is a block diagram of another embodiment of an intelligent bi-directional transceiver upon which embodiments of the present invention may be practiced.

FIGURE 1C is a perspective illustration of one embodiment of an intelligent bi-directional transceiver upon which embodiments of the present invention may be practiced.

FIGURE 1D is a perspective illustration of another embodiment of an intelligent bi-directional transceiver upon which embodiments of the present invention may be practiced.

FIGURE 1E is a block diagram of an exemplary digital broadcast system in accordance with one embodiment of the present invention.

FIGURE 2 is an illustration of the frequencies associated with different types of broadcast digital signals in accordance with one embodiment of the present invention.

FIGURE 3 is a block diagram of one embodiment of an intelligent bi-directional transceiver in accordance with the present invention.

FIGURE 4 is a flowchart of the steps in a process for transmitting and receiving digital signals using an intelligent bi-directional transceiver in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

In the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one skilled in the art that the present invention may be practiced without these specific details or with equivalents thereof. In other instances, well known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the present invention.

Some portions of the detailed descriptions which follow are presented in terms of procedures, logic blocks, processing, and other symbolic representations of operations on data bits within an intelligent electronic media device. These descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. A procedure, logic block, process, etc., is herein, and generally, conceived to be a self-consistent sequence of steps or instructions leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these physical manipulations take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated in a consumer electronic media device. For reasons of convenience, and with reference to common usage, these signals are referred to as bits, values, elements, symbols, characters, terms, numbers, or the like with reference to the present invention.

It should be borne in mind, however, that all of these terms are to be interpreted as referencing physical manipulations and quantities and are merely convenient labels and are to be interpreted further in view of terms commonly used in the art. Unless specifically stated otherwise as apparent from the following discussions, it is understood that throughout discussions of the present invention, discussions utilizing terms such as "receiving" or "transmitting" or "encrypting" or "descrambling" or "decoding" or "processing" or the like, refer to the action and processes (e.g., process 500 of Figure 4) of an electronic device such as a microcontroller or similar electronic computing device (e.g., dedicated or embedded computer system) that manipulates and transforms data. The data are represented as physical (electronic) quantities within the electronic device's registers and memories and is transformed into other data similarly represented as physical quantities within the electronic device memories or registers or other such information storage, transmission, or display screens.

Figure 1A is a block diagram of one embodiment of an intelligent bi-directional transceiver 300 (e.g., a set-top box) upon which embodiments of the present invention may be practiced. In the present embodiment, transceiver 300 includes front-end block 310 coupled to bus 305, conditional access block 330 coupled to front-end block 310 and bus 305, audio/video (A/V) decode block 340 coupled to conditional access block 330 and bus 305, graphics block 350 coupled to A/V decode block 340 and bus 305, and central processing unit 360 coupled to bus 305. Conditional access block 330, also referred to as a

point of deployment (POD) or an interface card, is adapted to receive smart card 325. Bus 305 is an internal address/data bus for communicating digital information between the functional blocks of transceiver 300. In one embodiment, bus 305 is a high bandwidth bus, for example a Peripheral Component Interconnect (PCI) bus, capable of communicating A/V data between the modularized blocks 310, 330, 340, 350 and 360.

Transceiver 300 receives digital broadcast signal 370 from a digital broadcast system (not shown). As a bi-directional set-top box, in addition to receiving digital broadcast signal 370, transceiver 300 can transmit messages to the digital broadcast system operator (e.g., a Multiple System Operator, MSO). For example, when a subscriber selects a premium service offered by the MSO, such as a pay-per-view event or movie, the subscriber's selection and any billing information can be transmitted to the MSO. Transceiver 300 can also be used for Internet communications, electronic mail ("e-mail"), and the like.

Digital broadcast signal 370 is a media signal comprising audio and video content. Digital broadcast signal 370 can be delivered to transceiver 300 using any of the various mechanisms currently in use or envisioned, such as a terrestrial line (e.g., a cable system), the World Wide Web (e.g., a connection to the Internet), or a wireless transmission (e.g., a satellite broadcast). In accordance with the present invention, a number of different digital broadcast signal formats in use or envisioned can be used, such as the Advanced Television Systems Committee (ATSC) digital television format.

In the present embodiment, front-end block 310 contains more than one tuner for receiving digital broadcast signal 370 and for transmitting information, messages, digital signals and the like. In this embodiment, front-end block 310 contains an in-band tuner for receiving an in-band transmission from the digital broadcast system. Front-end block 310 also includes an out-of-band tuner for receiving out-of-band signals from the digital broadcast system. In addition, front-end block 310 includes a cable modem or similar device for sending and receiving information to and from the World Wide Web, for sending and receiving electronic mail ("e-mail"), and for exchanging information with the digital broadcast system. Front-end block 310 also includes a device (e.g., a modem) that allows a telephone or digital subscriber line (DSL) connection to be made to the World Wide Web so that bi-directional communications, including e-mail, can occur over the Internet. It is appreciated that, in other embodiments, different combinations of these elements may be present. Additional information is provided in conjunction with Figure 3.

Therefore, in accordance with the present embodiment of the present invention, front-end block 310 contains substantially all of the devices needed for bi-directional communication. Thus, in accordance with the present invention, the devices needed by transceiver 300 for bi-directional communication are substantially located in a single functional block. By including the devices needed for bi-directional communication in a single block (e.g., front-end block 310), transceiver 300 is more readily manufactured, thus reducing costs to the manufacturer and ultimately to the consumer.

Furthermore, components outside of front-end block 310 can be changed, swapped out, etc., making the design of transceiver 300 more flexible so that it can be more readily adapted to different markets and MSOs. In addition, any specialized buses, control lines, data lines, etc., needed in order to accomplish bi-directional communication are also located in front-end block 310, thus facilitating exchanges between the devices within front-end block 310. Furthermore, in accordance with the present invention, it is no longer necessary for these exchanges to occur over bus 305, thus eliminating a portion of the communications that previously occurred over bus 305. By reducing traffic over bus 305, competition between devices for bus bandwidth are reduced, thereby improving the overall performance of transceiver 300 with regard to data handling and processing. Advantageously, by placing all of the bi-directional communication functionality in one block (e.g., on one card), a specialized bus may be utilized on the front end of the transceiver to maximize communication speed between devices on the front-end card, while simplifying the inter-module communication by requiring only a single, high-speed bus (e.g., a PCI bus). It is understood that each block includes an appropriate driver circuit to permit interface with the high-speed bus.

Continuing with reference to Figure 1A, in the present embodiment, central processing unit 360 contains a processor (not shown) for processing information and instructions. Central processing unit 360 also may contain random access memory, read only memory, one or more caches, a flash memory and the like (not shown) for storing information and instructions.

Smart card 325 stores information needed by a cable system operator or digital broadcast system operator (e.g., an MSO) to bill a subscriber for services used by the subscriber (for example, the viewing of a pay-per-view movie or event). Typically, smart card 325 also includes a key that is used to descramble digital broadcast signal 370 (if the signal is scrambled). In the present embodiment, smart card 325 is inserted into conditional access block 330; however, it is appreciated that in other embodiments smart card 325 may be coupled in a different manner to transceiver 300 (for example, it may be inserted into either front-end block 310 or A/V decode block 340). Using the key from smart card 325, conditional access block 330 descrambles digital broadcast signal 370.

Because digital broadcast signal 370 has been descrambled, the signal must be encrypted in order to prevent its unauthorized use and duplication. In the present embodiment, conditional access block 330 contains an encryption engine (not shown) that encrypts digital broadcast signal 370. In one embodiment, the encryption engine uses a well-known DES ECB (Data Encryption Standard Electronic Code Book) encryption routine and a key length of 56 bits. However, it is appreciated that other well-known and commercially available encryption routines and different key lengths may be used in accordance with the present invention.

In the present embodiment, A/V decode block 340 includes a decryption engine (not shown) for decrypting an encrypted digital broadcast signal 370.

However, it is appreciated that the decryption engine may be incorporated elsewhere in transceiver 300, downstream of the encryption engine. The output of the decryption engine is a decrypted digital signal that is "in the clear." The signal in the clear is decoded by A/V decode block 340.

In the present embodiment, A/V decode block 340 decodes the video content and the audio content of digital broadcast signal 370 using an MPEG (Moving Pictures Experts Group) video decoder and an AC3 (Digital Dolby) audio decoder; however, it is appreciated that other video or audio decoders can be used in accordance with the present invention. In addition, in one embodiment, A/V decode block 340 is capable of handling video and audio analog signals.

The inputs to graphics block 350 are the decoded video and audio digital signals from A/V decode block 340. In one embodiment, graphics block 350 also receives external audio and video analog inputs. Graphics block 350 processes the audio and video information and provides the output to, for example, a television set or a computer system (not shown) where it can be viewed and listened to.

Thus, in accordance with the present invention, transceiver 300 utilizes a modular architecture, comprising different functional blocks, each dedicated to a specific function required to be performed by transceiver 300 (e.g., receiving and sending data signals, decrypting and decoding, and audio and visual processing). The use of a modular architecture facilitates the manufacture of

transceiver 300, thereby reducing costs to the manufacturer as well as to consumers. The use of a modular architecture also improves the flexibility of the design of transceiver 300, allowing it to be more readily adapted for use in different markets and by different MSOs. For example, modules can be customized according to the requirements of the different markets and MSOs, then the appropriate modules selected to create a customized transceiver. In addition, the modular architecture in accordance with the present invention permits the use of a single bus (e.g., bus 305) for coupling the various functional blocks to each other, thereby simplifying communication between the modules and improving the overall performance of transceiver 300. Advantageously, by placing all of the bi-directional communication functionality in one block (e.g., on one card), a specialized bus may be utilized on the front end of the transceiver to maximize communication speed between devices on the front-end card, while simplifying the inter-module communication by requiring only a single, high-speed bus (e.g., a PCI bus).

Figure 1B is a block diagram of another embodiment of transceiver 300 upon which embodiments of the present invention may be practiced. In this embodiment, point of deployment (POD) 320 is separate from conditional access block 330, and smart card 325 is plugged into POD 320 instead of conditional access block 330. Smart card 325 contains a key for descrambling digital broadcast signal 370, and this key is used by POD 320 to descramble digital broadcast signal 370. POD 320 also encrypts digital broadcast signal 370 using an encryption engine (not shown). Although POD 320 is separate

from conditional access block 330 in this embodiment, conditional access block 330 can still exist in transceiver 300.

Figure 1C is an illustration of the embodiment of transceiver 300 of Figure 1B, upon which embodiments of the present invention may be practiced. In this embodiment, smart card 325 is inserted into POD 320, which is inserted into slot 390. Digital broadcast signal 370 is received by transceiver 300 and forwarded to POD 320, where it is descrambled and encrypted using a key provided by smart card 325. Subsequently, the digital signal is decrypted and the audio and visual content are decoded and processed by transceiver 300 as described above, and the result (output 380) is sent to, for example, a television (not shown) or similar device.

Figure 1D is an illustration of the embodiment of transceiver 300 of Figure 1A, upon which embodiments of the present invention may be practiced. In this embodiment, smart card 325 is inserted into an interface card (e.g., conditional access block 330 of Figure 1A) which is built into transceiver 300. Digital broadcast signal 370 is received by transceiver 300 and forwarded to conditional access block 330, where it is descrambled and encrypted using a key provided by smart card 325. Subsequently, the digital signal is decrypted and the audio and visual content are decoded and processed by transceiver 300 as described above, and the result (output 380) is sent to, for example, a television (not shown) or similar device.

Figure 1E is a block diagram providing an overview of a digital broadcast system 365 in accordance with one embodiment of the present invention. Audio and video content providers 385 (e.g., a broadcast system operator or MSO) provide digital broadcast signal 370 to transceiver 300. In the present embodiment, digital broadcast signal 370 can be provided using a terrestrial broadcast (e.g., a wireless broadcast), a satellite broadcast, a terrestrial line (e.g., cable), or an Internet connection. In accordance with the present invention, transceiver 300 includes a front-end block 310 containing the devices needed for bi-directional communication. Transceiver 300 also includes other functional blocks (e.g., back end functional blocks 375) including modularized blocks 310, 330, 340, 350 and 360 (Figures 1A and 1B). The output of transceiver 300 includes audio and video information provided to display device 395 (e.g., a television set or a computer system) so that this information can be viewed or listened to.

Figure 2 is an illustration of the various frequencies associated with different types of broadcast digital signals in accordance with one embodiment of the present invention. In this embodiment, the frequencies in the range of approximately 5-42 MHz are known as "upstream" signals, and the frequencies in the range of approximately 54-860 MHz are known as "downstream" signals. Within the upstream range, the range of frequencies from approximately 5-26 MHz are known as "out-of-band (OOB) upstream," and the range of signals from approximately 26-42 MHz are known as "cable modem upstream." Within the downstream range, the range of frequencies from approximately 70-130 MHz are known as "out-of-band downstream."

From the perspective of intelligent transceiver 300 (Figures 1A-1D), an upstream signal is transmitted and a downstream signal is received. The OOB upstream range is used by transceiver 300 to send payment information, for example, to the broadcast system operator or MSO. The cable modem upstream range is used for communicating with the World Wide Web, for sending e-mail, and the like. The in-band downstream range is for receiving audio and video content. The OOB downstream range is used for receiving electronic programming guide information and the key used by conditional access block 330 to descramble a scrambled broadcast digital signal.

Figure 3 is a block diagram of an intelligent bi-directional transceiver 400 (e.g., a bi-directional set-top box) showing additional details of the embodiments illustrated by Figures 1A and 1B. In the present embodiment, transceiver 400 includes front-end block 310, POD 320, smart card 325, conditional access block 330, A/V decode block 340, graphics block 350, and central processing unit 360. Front-end block 310, conditional access block 330, A/V decode block 340, graphics block 350, and central processing unit 360 are coupled via bus 305. Table 1 is a list of the various elements and acronyms contained in Figure 3.

Table 1
Elements and Acronyms of Transceiver Embodied in Figure 3

AVDAC	Audio Video Digital-to-Analog Converter
BTSC	Broadcast Television Systems Committee
D-Cache	Data Cache
DAVIC	Digital Audio Visual Council
DOCSIS	Data Over Cable Service Interface Specification
DSM	Diplexer, Splitter Module

DSP	Digital Signal Processor
DVD	Digital Video Disk
FAT	Forward Application Tuner
FPU	Floating Point Unit
I/F	Interface
IDCT	Inverse Discrete Cosine Transform
Inst. Cache	Instruction Cache
Int. Cont.	Interrupt Controller
MAC	Media Access Control
MC	Motion Compensation
MCNS	Multiple Cable Network System
MIDI	Musical Instrument Digital Interface
MP@ML	Main Profile at Main Level
OOB	Out of Band
PCI	Peripheral Component Interconnect
PCM	Pulse Coded Modulation
PLL	Phase Locked Loop
QPSK	Quadrature Phase Shift Keying
QPSKQAM	QPSK Quadrature Amplitude Modulation
RTC	Real Time Clock
SLIC	Serial Line Internet Connection
UART	Universal Asynchronous Receiver-Transmitter
VBI	Vertical Blanking Interval
VIF/SIF	Video Intermediate Frequency/Sound Intermediate Frequency

With reference to Figure 3, in the present embodiment, front-end block 310 includes an integrated circuit device 405 for handling upstream and downstream digital signals (see Figure 2). Front-end block 310 receives an in-band digital broadcast signal from a digital broadcaster via in-band tuner 401. An OOB digital broadcast signal is received via OOB tuner 402. In the present embodiment, front-end block 310 includes a cable modem coupled to MCNS FAT tuner 403. The cable modem and MCNS FAT tuner 403 can also be used for sending digital signals and information to the World Wide Web, for sending and receiving electronic mail ("e-mail"), and for exchanging information with the digital broadcast system. Front-end block 310 also includes an input/output device (e.g., modem 404) that allows a telephone or digital subscriber line

(DSL) connection to be made to the World Wide Web so that bi-directional communications, including e-mail, can occur over the Internet. It is appreciated that, in other embodiments, different combinations of these elements may be present.

In one embodiment, integrated circuit device 405 is Open-Cable compliant. In this embodiment, integrated circuit device 405 can demodulate a QAM in-band signal (e.g., a 64/256 QAM in-band signal, 406) and support FEC (forward error correction) specifications (e.g., FEC J.83, Annex A/B). The transport stream output can support both serial and parallel ports. Integrated circuit device 405 and OOB tuner 402 can demodulate QPSK (407) and may be compatible with DAVIC/Digicipher 2 FEC specifications. Integrated circuit device 405 can also modulate the upstream data signal to QPSK/16QAM (415) and may be capable of equalizing the FEC encoding with Starvue/MCNS/ DAVIC (408). The upstream digital data signals can also be output in analog. MAC controller 409 can comply with DAVIC/MCNS and has a router for outputting a signal to an external computer system through an Ethernet interface 413. Integrated circuit device 405 also includes DSP 414 for use with IP (Internet Protocol) telephony. It is appreciated that, in another embodiment, the devices integrated into integrated circuit device 405 can be integrated into multiple integrated circuits within front-end block 310.

Smart card 325 includes a key to descramble a scrambled digital broadcast signal. It is appreciated that Figure 3 shows, in a combined form, both of the embodiments illustrated by Figures 1A and 1B. In the case of the

embodiment illustrated by Figure 1A, smart card 325 is inserted into conditional access block 330, and conditional access block 330 descrambles and encrypts the digital broadcast signal. In the case of the embodiment illustrated by Figure 1B, smart card 325 is plugged into POD 320. In this latter embodiment, the descrambling and encrypting functions are performed in POD 320, and so these functions are bypassed in conditional access block 330.

Continuing with reference to Figure 3, the encrypted digital signal is delivered to A/V decode block 340 via conditional access block 330. In the present embodiment of the present invention, a decryption engine 345 is integrated into demultiplexer ("demux") 410. Decryption engine 345 decrypts an encrypted signal (e.g., digital broadcast signal 370) received by A/V decode block 340 via conditional access block 330.

Continuing with reference to Figure 3, in the present embodiment, A/V decode block 340 includes an MPEG decoder (e.g., MP@ML DEC block 411) and an audio decoder (e.g., AC-3 block 412) to decode the video and audio content of digital broadcast signal 370. Graphics block 350 processes the audio and video information received from A/V decode block 340. Central processing unit 360 contains a processor (e.g., CPU core 430) and memory (e.g., instruction cache 420) for processing information and instructions used by transceiver 400. It is appreciated that these functional blocks may include one integrated circuit device ("chip") or they may include a plurality of chips.

Thus, in accordance with the present invention, transceiver 400 utilizes a modular architecture, comprising different functional blocks, each dedicated to a specific function required to be performed by transceiver 400. The use of a modular architecture facilitates the manufacture of transceiver 400, thereby reducing costs to the manufacturer as well as to consumers. The use of a modular architecture also improves the flexibility of the design of transceiver 400, allowing it to be more readily adapted for use in different markets and by different MSOs. For example, the modules can be customized according to the requirements of the different markets and MSOs, then the appropriate modules selected to create a customized transceiver. In addition, the modular architecture in accordance with the present invention permits the use of a single bus (e.g., bus 305) for coupling the various functional blocks to each other, thereby simplifying communication between the modules and improving the overall performance of transceiver 400.

Figure 4 is a flowchart of the steps in a process 500 for enabling bi-directional communication using a transceiver (e.g., transceiver 400 of Figure 3) in accordance with one embodiment of the present invention. With reference also to Figure 3, in the present embodiment, process 500 is implemented as program instructions that are stored in memory (e.g., instruction cache 420) and executed by a processor (e.g., CPU core 430) of transceiver 400. It is appreciated that process 500 may be utilized in devices other than transceiver 400.

In step 510 of Figure 4, with reference also to Figures 1A and 1B, a digital broadcast signal (e.g., digital broadcast signal 370) is received by transceiver 300. In the present embodiment, digital broadcast signal 370 is received by front-end block 310. Typically, digital broadcast signal 370 is scrambled but not encrypted when it is received by transceiver 300.

In step 520, in the present embodiment, digital broadcast signal 370 is sent from front-end block 310 to a first functional block, where the signal is descrambled. In the embodiment of Figure 1A, digital broadcast signal 370 is sent from front-end block 310 to conditional access block 330. In the embodiment of Figure 1B, digital broadcast signal 370 is sent from front-end block 310 to POD 320. Depending on the embodiment, a smart card (e.g., smart card 325) is coupled to conditional access block 330 or POD 320. Smart card 325 contains a key that is used to descramble digital broadcast signal 370.

Continuing with step 520, in the present embodiment, digital broadcast signal 370 is encrypted. In the embodiment of Figure 1A, conditional access block 330 contains an encryption engine that is used to encrypt digital broadcast signal 370. In the embodiment of Figure 1B, POD 320 contains an encryption engine that is used to encrypt digital broadcast signal 370. In one embodiment, the encryption engine uses a well-known DES ECB encryption routine and a key length of 56 bits. However, it is appreciated that other encryption routines and different key lengths may be used in accordance with the present invention.

In step 530 of Figure 4, in the present embodiment, digital broadcast signal 370 (now descrambled and encrypted) is sent from the first functional block (e.g., either conditional access block 330 of Figure 1A or POD 320 of Figure 1B) to A/V decode block 340 (Figures 1A and 1B). In the embodiment of Figure 1B, digital broadcast signal 370 is sent from POD 320 to A/V decode block 340 via conditional access block 330. In each of the embodiments of Figures 1A and 1B, the link between conditional access block 330 and A/V decode block 340 is separate from bus 305; that is, there is a direct connection between conditional access block 330 and A/V decode block 340 that bypasses bus 305.

Continuing with step 530, digital broadcast signal 370 is decrypted and processed by A/V decode block 340. In the present embodiment, an MPEG (Moving Pictures Experts Group) video decoder and an AC3 (Digital Dolby) audio decoder are used; however, it is appreciated that other video or audio decoders can be used in accordance with the present invention.

In step 540, the output of A/V decode block 340 is provided to graphics block 350, where additional processing of the audio and video information is performed so that it can be displayed and/or listened to on a television set, computer system, or the like.

In step 550, a digital signal is sent from front-end block 310. The digital signal may represent an outgoing message (e.g., e-mail, or communication with

a Web site). The digital signal may also represent billing information being sent from conditional access block 330 to the broadcast system operator or MSO.

In summary, the present invention provides an apparatus and method thereof for enabling bi-directional communication between an intelligent transceiver (e.g., a set-top box) and a digital broadcast system (e.g., satellite systems, interactive World Wide Web access systems, and digital cable systems). In accordance with the present invention, a modular architecture is used for an intelligent transceiver, and the devices needed for bi-directional communication are substantially located in a single functional block (e.g., a front-end block). Consequently, the manufacture of the intelligent transceiver is facilitated, and the design of the intelligent transceiver can be more readily adapted to the specific requirements of the market where it will be utilized, thereby reducing manufacturing costs. In addition, communication between the devices used for bi-directional communication takes place in the front-end block. Accordingly, the amount of communication required over the bus is reduced, thereby improving the overall processing and data handling performance of the transceiver.

The preferred embodiment of the present invention, method and apparatus for a modularized bi-directional tuning system, is thus described. While the present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

CLAIMS

What is claimed is:

1. An intelligent transceiver comprising:

a bus;

a plurality of modular functional blocks communicatively coupled to said bus; and

a front-end block comprising:

an integrated circuit device coupled to said bus and configured for bi-directional communication;

wherein devices necessary for said bi-directional communication are substantially disposed within said front-end block.

2. The intelligent transceiver of Claim 1, wherein said intelligent transceiver is capable of bi-directional communication with a digital broadcast system, and said front-end block is adapted to send an outgoing digital signal to and receive an incoming digital signal from said digital broadcast system.

3. The intelligent transceiver of Claim 1, wherein said front-end block further comprises:

an in-band tuner for receiving an in-band digital signal from a digital broadcast system, said in-band digital signal containing audio content and video content;

an out-of-band tuner for receiving an out-of-band digital signal from said digital broadcast system; and

a third tuner for receiving and transmitting digital signals via a cable modem;

and wherein said bus comprises a high speed bus for communicating

audio and video data thereon, and said intelligent transceiver further comprises:

a central processing unit coupled to said bus;

a conditional access block coupled to said front-end block, said conditional access block for descrambling a scrambled digital signal;

an audio/video decode block coupled to said bus and comprising an integrated circuit device configured for decoding said audio content and said video content; and

a graphics block coupled to said bus and comprising an integrated circuit device configured for processing decoded audio content and decoded video content.

4. A method for transmitting and receiving digital signals using an intelligent transceiver, said method comprising the steps of:

a) receiving an incoming digital signal from a digital broadcast system at a front-end block of said intelligent transceiver, said front-end block comprising an integrated circuit device configured for bi-directional communication; and

b) transmitting an outgoing digital signal from said front-end block to said digital broadcast system;

wherein devices necessary for said bi-directional communication are substantially disposed within said front-end block.

5. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 4 wherein said step a) comprises the step of:

a1) receiving from said digital broadcast system an in-band digital signal

containing audio content and video content, said step a1) performed by an in-band tuner situated within said front-end block and coupled to said integrated circuit device.

6. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 4 wherein said step a) comprises the step of:

a2) receiving from said digital broadcast system an out-of-band digital signal, said step a2) performed by an out-of-band tuner situated within said front-end block and coupled to said integrated circuit device.

7. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 4 wherein said step a) and said step b) comprise the step of:

receiving and sending digital signals via a cable modem using a tuner situated within said front-end block and coupled to said integrated circuit device.

8. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 4 wherein said step a) and said step b) comprise the step of:

receiving and sending digital signals via a telephone connection using an input/output device situated within said front-end block and coupled to said integrated circuit device.

9. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 4 further comprising the steps of:

c) descrambling a scrambled digital signal received by said front-end block using a descrambler unit in a conditional access block; and

d) encrypting a descrambled digital signal using an encryption unit in said conditional access block.

10. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 9 further comprising the step of:

e) decoding said audio content and said video content using an audio/video decode block.

11. The method for transmitting and receiving digital signals using an intelligent transceiver as recited in Claim 10 further comprising the step of:

f) processing decoded audio content and decoded video content using a graphics block.

12. The intelligent transceiver of Claims 1-3 or the method of Claims 4-11, wherein said front-end block further comprises:

an in-band tuner coupled to said integrated circuit device and adapted to receive from said digital broadcast system an in-band digital signal containing audio content and video content.

13. The intelligent transceiver of Claims 1-3 or the method of Claims 4-11, wherein said front-end block further comprises:

an out-of-band tuner coupled to said integrated circuit device and adapted to receive an out-of-band digital signal from said digital broadcast system.

14. The intelligent transceiver of Claims 1-3 or the method of Claims 4-11, wherein said front-end block further comprises:

a tuner for sending and receiving digital signals via a cable modem.

15. The intelligent transceiver of Claims 1-3 or the method of Claims 4-11, wherein said front-end block further comprises:

an input/output device for sending and receiving digital signals via a telephone connection.

16. The intelligent transceiver of Claims 1-3 wherein said plurality of modular functional blocks comprises:

a conditional access block coupled to said front-end block and comprising a descrambler unit for descrambling a digital signal received by said front-end block.

17. The intelligent transceiver of Claims 1-3 wherein said plurality of modular functional blocks comprises:

a conditional access block coupled to said front-end block and comprising an encryption unit for encrypting a digital signal received by said front-end block.

18. The intelligent transceiver of Claim 17 wherein said digital broadcast signal is encrypted using an encryption routine substantially compliant with DES ECB (Data Encryption Standard Electronic Code Book).

19. The intelligent transceiver of Claims 1-3 wherein said plurality of modular functionality blocks comprises:

an audio/video decode block coupled to said bus and comprising an integrated circuit device configured for decoding said audio content and said video content.

20. The intelligent transceiver of Claim 1-3 wherein said plurality of modular functionality blocks comprises:

a graphics block coupled to said bus and comprising an integrated circuit device configured for processing said audio content and said video content.

21. The intelligent transceiver of Claim 12 wherein said audio content is substantially compliant with a version of the AC3 format.

22. The intelligent transceiver of Claim 12 wherein said video content is substantially compliant with a version of the MPEG (Moving Pictures Experts Group) format.

23. The intelligent transceiver of Claims 1-3 further comprising:

an input/output device for receiving and transmitting digital signals via a telephone connection.

24. The intelligent transceiver of Claims 1-3 further comprising:

an encryption unit coupled to said front-end block, said encryption unit for encrypting a digital signal received by said front-end block.

25. The intelligent transceiver of Claim 24 wherein said digital signal is encrypted using an encryption routine substantially compliant with DES ECB (Data Encryption Standard Electronic Code Book).

26. The intelligent transceiver of Claim 3 wherein said audio content is substantially compliant with a version of the AC3 format.

27. The intelligent transceiver of Claim 3 wherein said video content is substantially compliant with a version of the MPEG (Moving Pictures Experts Group) format.

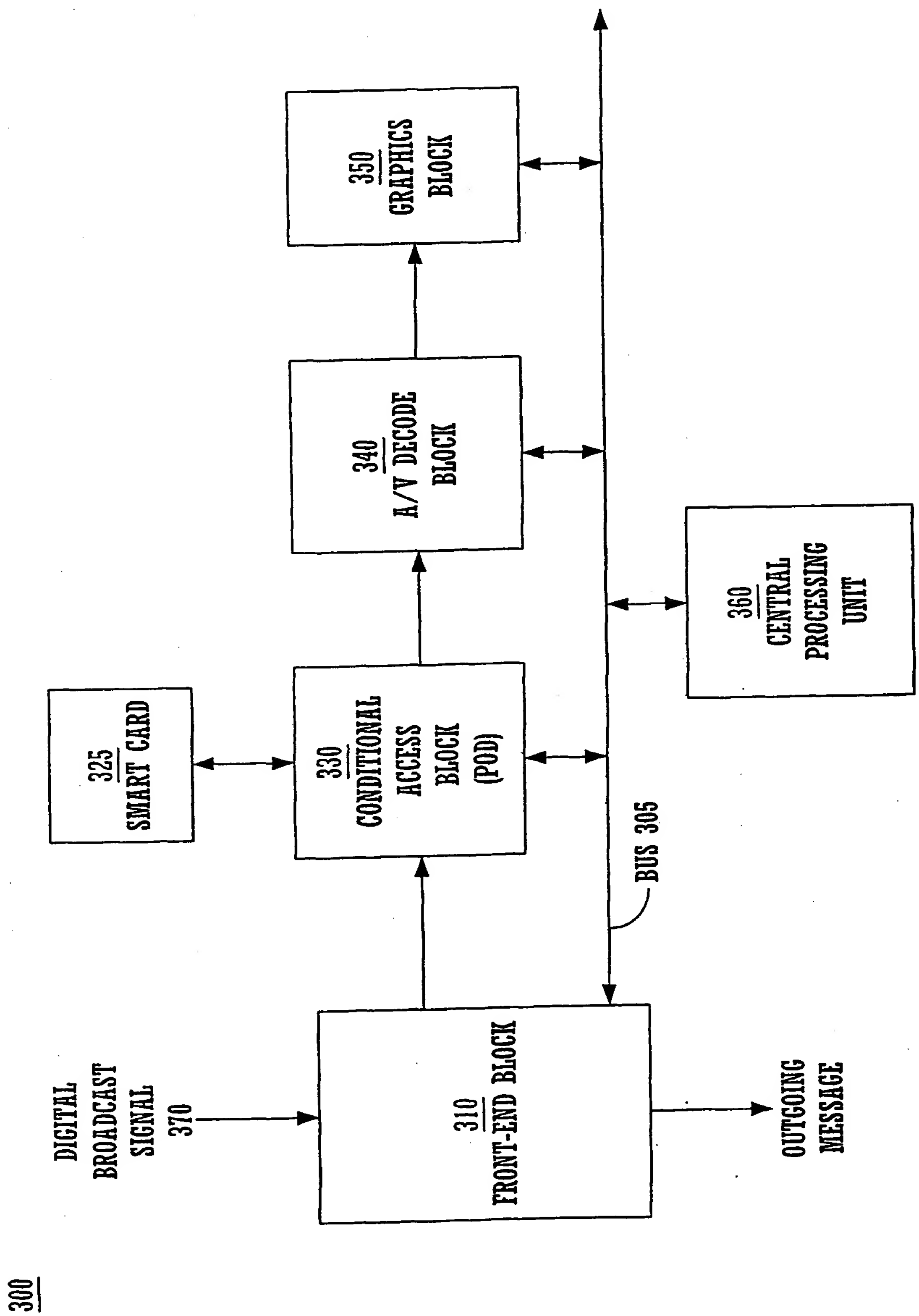
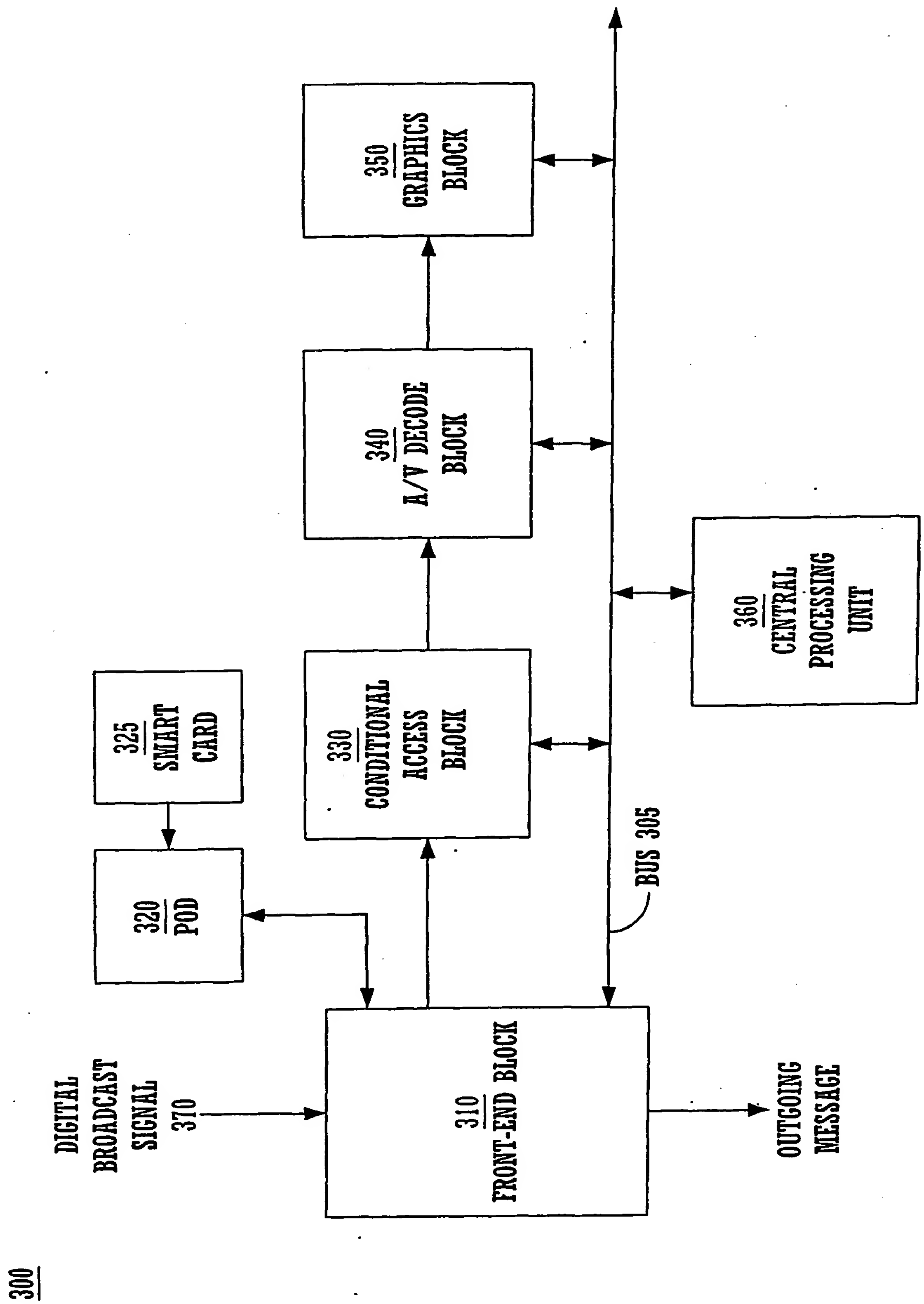

300
DIGITAL BROADCAST SIGNAL 370
310 FRONT-END BLOCK
OUTGOING MESSAGE
325 SMART CARD
330 CONDITIONAL ACCESS BLOCK (POD)
340 A/V DECODE BLOCK
350 GRAPHICS BLOCK
360 CENTRAL PROCESSING UNIT
BUS 305

FIGURE 1A



300
DIGITAL BROADCAST SIGNAL 370
310 FRONT-END BLOCK
OUTGOING MESSAGE
320 POD
325 SMART CARD
330 CONDITIONAL ACCESS BLOCK
340 A/V DECODE BLOCK
350 GRAPHICS BLOCK
360 CENTRAL PROCESSING UNIT
BUS 305

FIGURE 1B

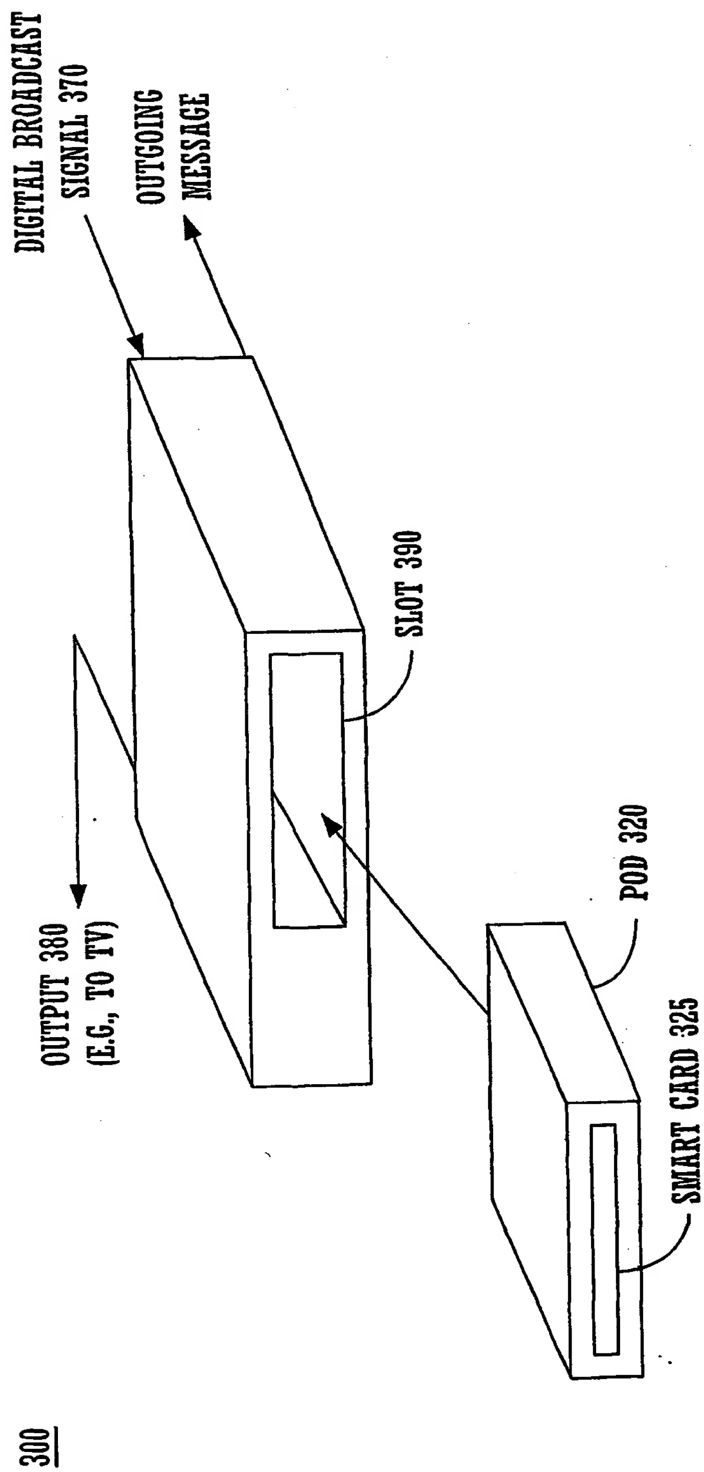

DIGITAL BROADCAST SIGNAL 370
OUTGOING MESSAGE
SLOT 390
POD 320
SMART CARD 325
OUTPUT 380 (E.G., TO TV)
300

FIGURE 1C

300

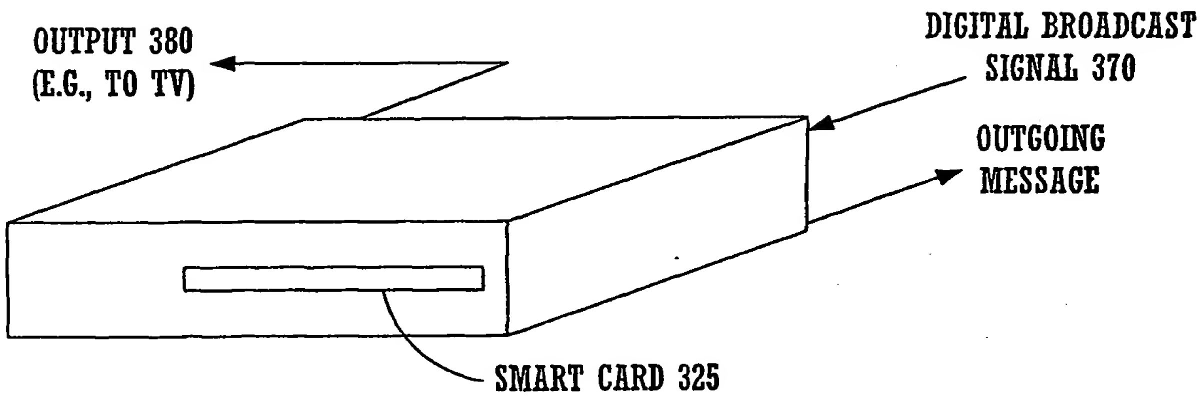


FIGURE 1D

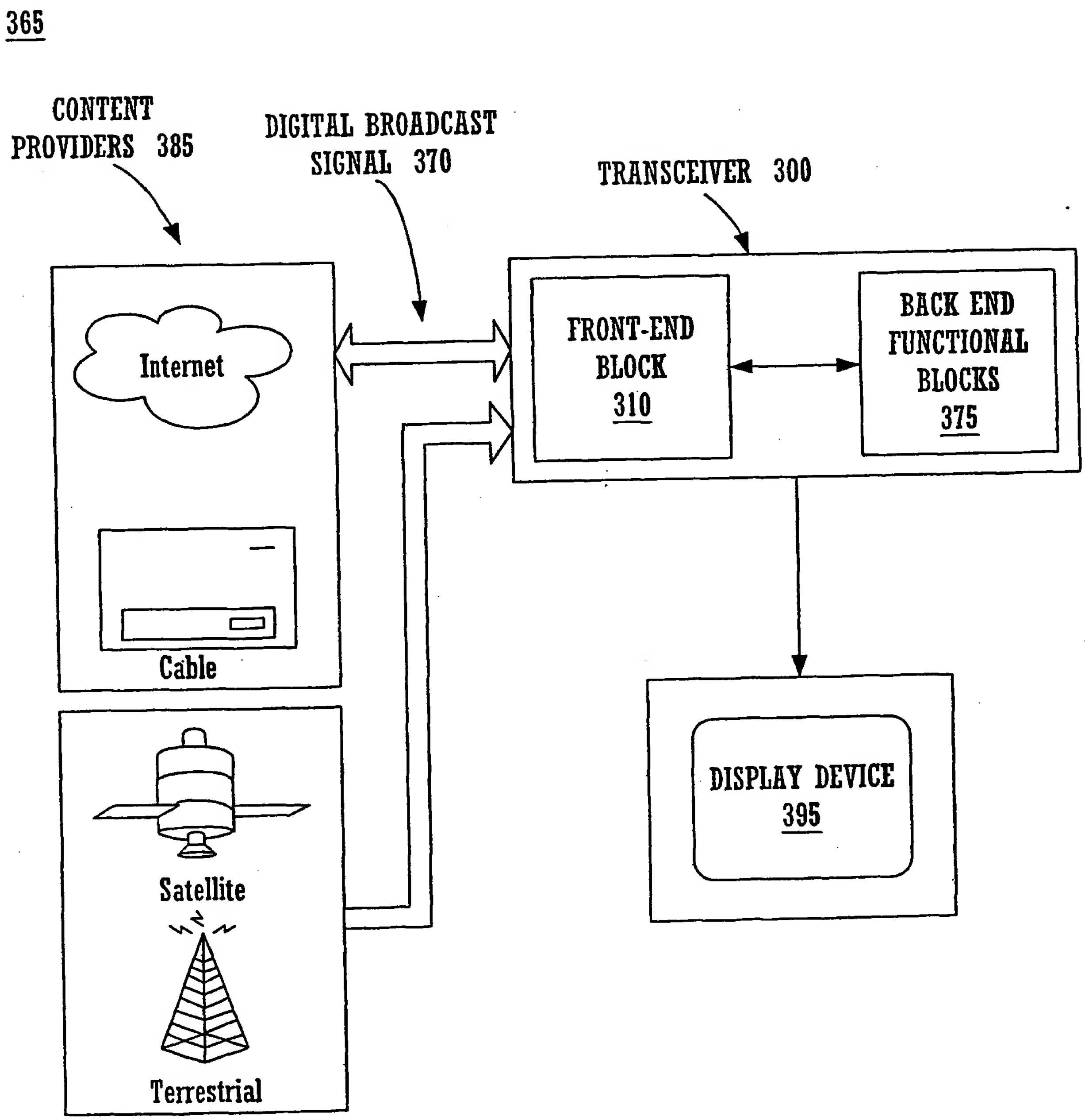

365
CONTENT PROVIDERS 385
DIGITAL BROADCAST SIGNAL 370
TRANSCEIVER 300
Internet
FRONT-END BLOCK 310
BACK END FUNCTIONAL BLOCKS 375
Cable
Satellite
Terrestrial
DISPLAY DEVICE 395

FIGURE 1E

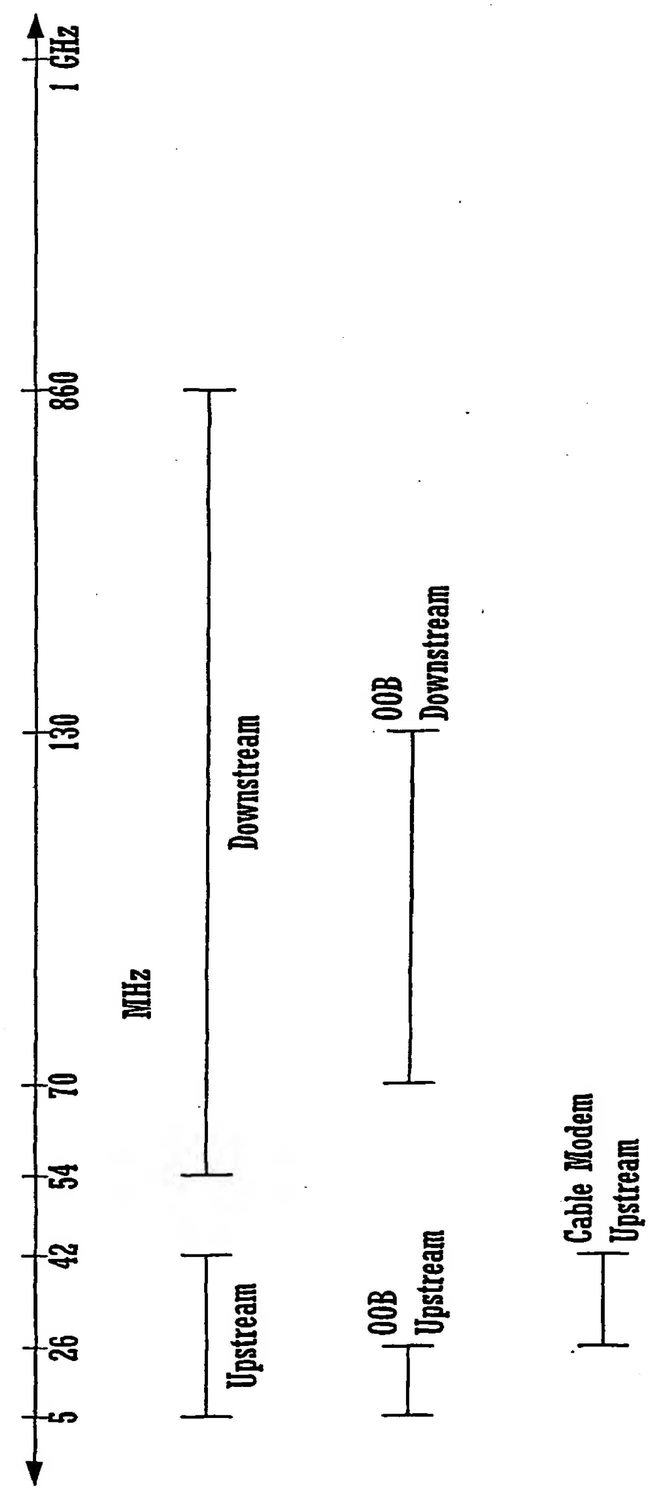

1 GHz
860
130
70
54
42
26
5
MHz
Downstream
Upstream
OOB
Downstream
OOB
Upstream
Cable Modem
Upstream

FIGURE 2

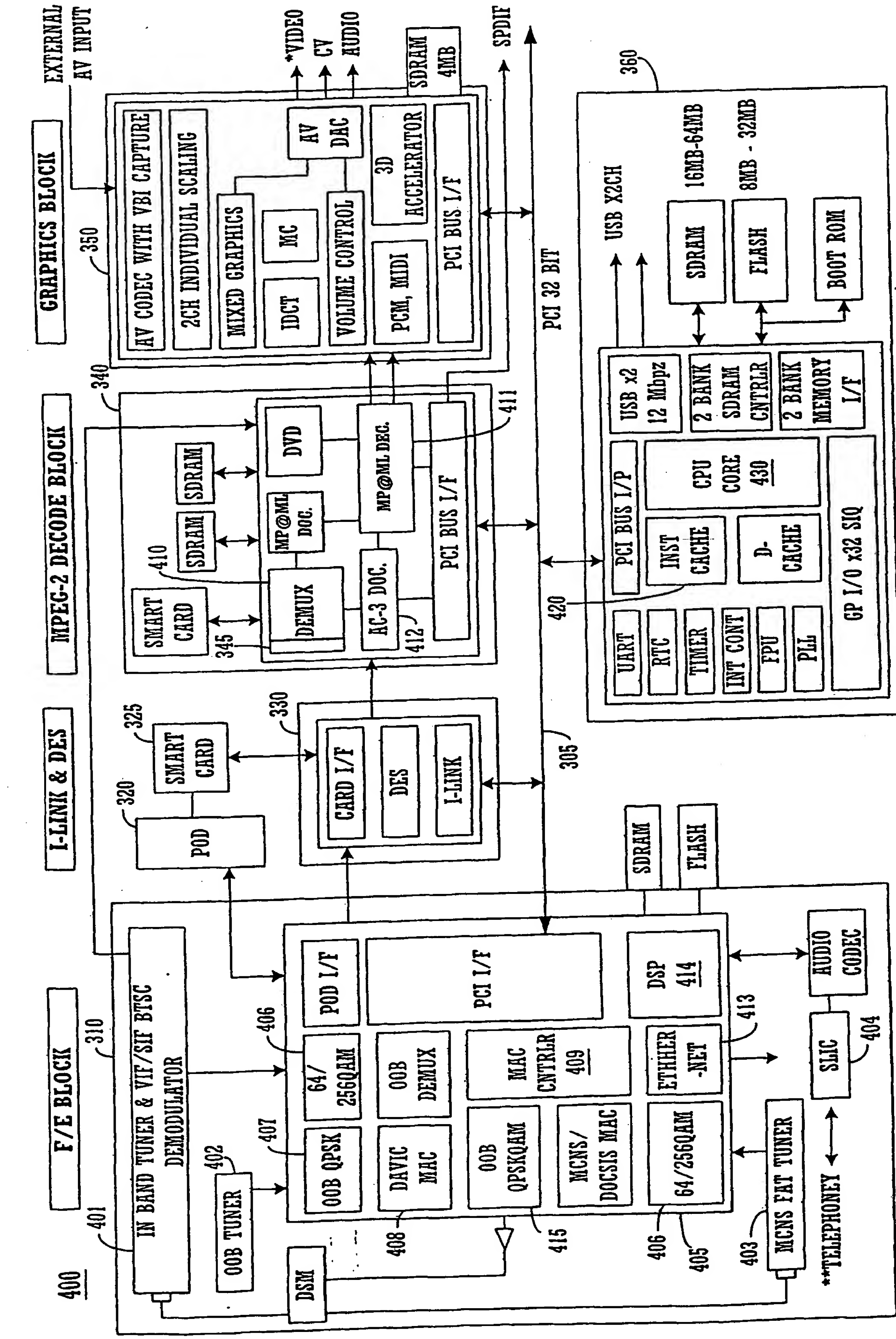

400
F/E BLOCK
310
401
IN BAND TUNER & VIF/SIF BTSC DEMODULATOR
402
OOB TUNER
DSM
406
64/ 256QAM
407
OOB QPSK
POD I/F
PCI I/F
DSP 414
OOB DEMUX
DAVIC MAC
MAC CNTRLR 409
OOB QPSKQAM
MCNS/ DOCSIS MAC
ETHHER -NET
64/256QAM
408
415
406
405
413
403
MCNS FAT TUNER
**TELEPHONEY
SLIC
404
AUDIO CODEC
SDRAM
FLASH
I-LINK & DES
320
POD
325
SMART CARD
330
CARD I/F
DES
I-LINK
305
MPEG-2 DECODE BLOCK
340
SMART CARD
345
DEMUX
410
SDRAM
SDRAM
MP@ML DOC.
DVD
MP@ML DEC.
AC-3 DOC.
412
PCI BUS I/F
411
PCI 32 BIT
420
GRAPHICS BLOCK
350
EXTERNAL AV INPUT
AV CODEC WITH VBI CAPTURE
2CH INDIVIDUAL SCALING
MIXED GRAPHICS
IDCT
MC
VOLUME CONTROL
AV DAC
PCM, MIDI
3D ACCELERATOR
PCI BUS I/F
*VIDEO
CV
AUDIO
SDRAM 4MB
SPDIF
360
USB X2CH
16MB-64MB
8MB - 32MB
SDRAM
FLASH
BOOT ROM
USB x2 12 Mbpz
2 BANK SDRAM CNTRLR
2 BANK MEMORY I/F
PCI BUS I/P
CPU CORE 430
INST CACHE
D-CACHE
GP I/O x32 SIQ
UART
RTC
TIMER
INT CONT
FPU
PLL
CPU BLOCK

FIGURE 3

500

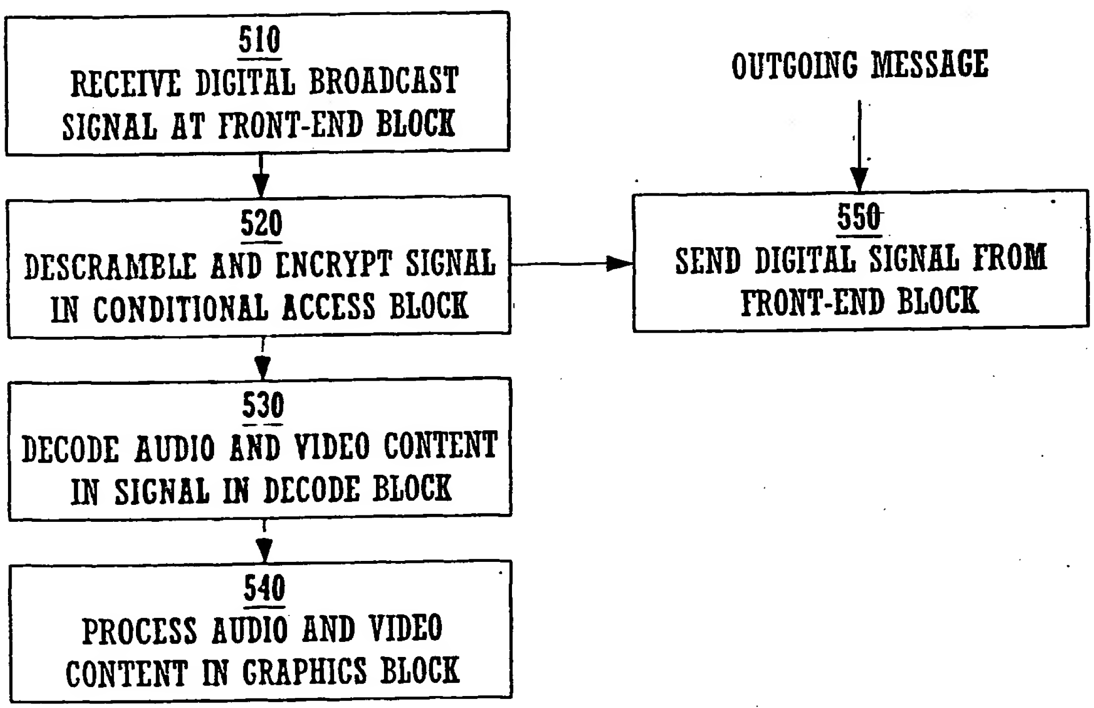

510
RECEIVE DIGITAL BROADCAST SIGNAL AT FRONT-END BLOCK
520
DESCRAMBLE AND ENCRYPT SIGNAL IN CONDITIONAL ACCESS BLOCK
530
DECODE AUDIO AND VIDEO CONTENT IN SIGNAL IN DECODE BLOCK
540
PROCESS AUDIO AND VIDEO CONTENT IN GRAPHICS BLOCK
OUTGOING MESSAGE
550
SEND DIGITAL SIGNAL FROM FRONT-END BLOCK

FIGURE 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/09739

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :H04N 7/173
US CL :725/131
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 725/131-134, 100, 89, 68, 49; H04N 7/16, 7/173

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,960,445 A (TAMORI et al.) 28 September 1999 figures 1-4	1-2,4,8-11 15-20,23, 24,27
X	US 5,828,419 A (BRUETTE et al.) 27 October 1998 figure 1	1-2,4, 8-10,13, 15-27
X	US 5,771,064 A (LETT) 23 June 1998 whole document	1-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 JULY 2001	08 AUG 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer CHRISTOPHER GRANT Telephone No. (703) 305-4755

Form PCT/ISA/210 (second sheet) (July 1998)★